SECTION 701

PORTLAND CEMENT CONCRETE

This Specification covers all materials, classification, mix designs, proportioning, and testing of portland cement concrete. All concrete shall be air entrained unless otherwise shown on the Plans.

The equipment and tools necessary for the mixing of concrete shall meet the requirements of Subsection 414.03.

701.01. MIX DESIGN AND PROPORTIONING.

(a) **Classes of Concrete.** The classes of concrete are shown in the following table:

CLASSES OF CONCRETE

Class of Concrete	Minimum Cement Content[a], lb/y ^{3}(kg/m^3)	Air Content, Percent	Maximum Water/Cement Ratio[b], lb/lb (kg/kg)	Slump[c], inches (mm)	Minimum 28-day Compressive Strength[d], psi (kPa)
AA	611 (363)	6.5±1.5	.44	2±1 (50±25)	4000 (27,580)
A	564 (335)	6±1.5	.48	2±1 (50±25)	3000 (20,685)
AP	470 (279)	6±1.5	.48	2±1 (50±25)	3000 (20,685)
C	395 (234)	6±1.5	.62	3±1 (75±25)	2400 (16,550)
P	611 (363)	5±1.5	.44	3±1 (75±25)	As specified

a *Cement Substitution.* Fly ash meeting the requirements of Section 702 may be substituted for up to 15% (20% from April through October) of the required cement. Ground granulated blast furnace slag meeting the requirements of AASHTO M 302 Grade 100 or Grade 120 may be substituted for up to 25% of the required cement. A combination of up to 25% ground granulated blast furnace slag and up to 15% fly ash may be substituted for up to 40% of the required cement. From April through October, a combination of up to 25% ground granulated blast furnace slag and up to 20% fly ash may be substituted for up to 45% of the required cement. Substitution shall be by weight: 1.0 pound (1 kg) for each 1.0 pound (1 kg) of cement. The concrete mix design shall be appropriately adjusted. These substitutions will not be allowed for high early strength concrete, Class P concrete or concrete containing Type IP, Type I (PM), or Type I (SM) cement. If the specified minimum cement content is satisfied, additional fly ash or ground granulated blast furnace slag, or silica fume complying with ASTM C 1240, may be added to the mix when approved as part of the mix design.

b *Water Cement Ratio.* Using the weight in pounds of each material, calculate the water-cement ratio (W/C) by the following equation:

W/C = Water/ (Cement + Fly Ash + Blast Furnace Slag + Silica Fume)

The water actually used is determined by the water measured into the batch plus the free water on wet aggregate minus the water absorbed by dry aggregate plus water in any admixture solutions and shall not exceed the limit specified.

c Slump. The slump shall be as shown, or as specified in the contract documents, or as approved by the Engineer, and the consistency required shall be that which will provide satisfactory workability for the type work being done. Slump tests will be made during the progress of the work as a measure of uniformity of the consistency of the concrete. If using a high-range water reducing admixture, limit the slump to a maximum of 9 inches (230 mm).

d Compressive Strength. Compressive strength is based on the average of three test cylinders. The compressive strength requirements of Class P concrete will be specified in the contract documents.

When the class of concrete is not expressly indicated on the Plans, the following requirements shall govern:

- *Class AA*. Use Class AA concrete in superstructure items, such as bridge floors, approach slabs, reinforced concrete piles, drilled shaft foundations, parapet walls, concrete rail and handrails.

- *Class A.* Use Class A concrete for pavements and in substructures items, such as pier caps, columns, abutments, retaining walls, box culverts, and all reinforced concrete not requiring Class AA concrete.

- *Class AP*. Use Class AP concrete in shoulders, merge areas and gore areas for PCC pavements, unless otherwise directed by plan notes.

- *Class C*. Use Class C concrete for soil erosion control structures.

- *Class P*. Use Class P concrete for precast prestressed concrete members, such as PC beams, double tees, prestressed concrete piling, and stay-in-place precast concrete deck panels, and cast-in-place post-tensioned structures.

(b) **Proportioning.** Base the mix design on absolute volume for the class of concrete specified and the consistency suitable for satisfactory placement of the concrete. Design and produce concrete mixtures that conform to the Class of Concrete table in this section and base the mix design on absolute volume. Proportion the coarse and fine aggregate in accordance with ACI 211.1. Use the least amount of sand and mixing water which will ensure concrete of the required workability for placement conditions. Meet the minimum strength within 72 hours of placement for high early strength concrete. Submit the mix design at least 14 days before production to the Engineer. Include at least the following information with each mix design:

a. Project identification
b. Name and address of contractor and producer
c. Mix design designation
d. Intended use of the mix design
e. Expected travel time from batch to placement
f. If the concrete will be pumped or not

g. Aggregate sources, gradation, moisture content, saturated surface dry batch mass, LA abrasion (AASHTO T 96-92), and freeze thaw durability (AASHTO T 103-91).
h. Fineness modulus of fine aggregate
i. Cement type and source
j. Type of cement replacement, if used, and source
k. Type of admixtures and sources
l. Material proportions
m. Air content
n. Slump
o. Water / cement ratio
p. Strengths at 7 and 28 days
q. Strengths at 72 hours for high early strength concrete.

NOTE: Do not place any concrete until the mix design is approved.

Submit new mix designs if:
1. The mix design is rejected by the Engineer
2. The source of any material changes
3. The mix design produces unacceptable workability or production test results.

(c) **Tests and Samples.** Conduct fresh concrete sampling using AASHTO T141. If pumped, sample concrete after discharge from the pump. Determine the slump using AASHTO T119, and the air content using AASHTO T121, AASHTO T152 or AASHTO T196 as appropriate. Make and cure test specimens in accordance with AASHTO T23, except, after initial curing, specimens for acceptance testing will be cured in a medium maintained at 40°F (4°C) to 85°F (29°C) until tested. Test specimens for acceptance according to AASHTO T22 for cylinders.

701.02. PORTLAND CEMENT.

Portland cement shall conform to the requirements of AASHTO M 85 or AASHTO M 240.

Type I, Type I(SM), Type I(PM), and Type IP shall be used in concrete for general concrete construction. When white portland cement is required, it shall meet the requirements of Type I.

Type II shall be used in concrete exposed to moderate sulphate action or moderate heat of hydration, when specified on the Plans or in the Proposal.

Type III may be used when high early strength concrete is required.

Unless otherwise approved by the Engineer, the product of only one mill of any one brand and type of portland cement shall be used on any structure or adjacent structures.

Provide suitable means of storing and protecting the cement against dampness.

NOTE: *Cement which for any reason has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.*

All methods of sampling and testing shall be in accordance with the requirements of AASHTO M 85 or AASHTO M 240, except as modified by the Department's acceptance policy: "Procedure for Sampling, Testing and Acceptance of Portland Cement." Copies of the procedure are available at the office of the Materials Engineer.

701.03. ADMIXTURES.

Use admixtures included in the approved mix design only, unless otherwise specified in the contract documents. This subsection does not specify requirements covering fly ash, ground granulated blast furnace slag, or silica fume. In addition, admixtures shall not be used to replace cement, and admixtures containing chlorides such as Cl^- in excess of ten thousand ppm shall not be used in prestressed or reinforced concrete.

- Accurately measure admixtures into each batch by methods approved by the Engineer.
- Dispense admixtures in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to pre-measured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. Do not allow the dosage to vary more than 5 percent from the dosage established by the mix design for the mix requirements. Make sure the measuring equipment allows for easy confirmation of the accuracy of measurement of the admixture dosage.
- Store admixtures in a manner to prevent freezing and agitate them to prevent separation or sedimentation of solids. Do not use air agitation.
- If more than one liquid admixture is used, be certain that they are compatible, and dispense each one by separate equipment.

NOTE: Any type of admixture shall be uniform in properties throughout its use in the work; if the furnished admixture is not uniform in properties, discontinue using it. Use only those admixtures which have been approved by the Materials Engineer. A list of approved commercial admixtures is maintained by the Materials Division.

NOTE: Admixtures not on the approved list may be accepted if the manufacturer presents a type A certification defined in Subsection 106.04 that the admixture meets all the requirements of AASHTO M 154 or AASHTO M 194 as appropriate.

Furnish the Engineer a type C certification from the manufacturer with each lot or shipment to the effect that the admixture supplied for use in the work is identical in all essential respects, including concentration, to the admixture tested and approved under these Specifications.

(a) **Air Entraining Admixtures.** Air entraining admixtures shall conform to AASHTO M 154. An exception to the above requirement may be granted in the case of admixtures manufactured by neutralizing vinsol resin with caustic soda provided the manufacturer furnishes certification that the product is neutralized vinsol resin and contains no other additive. Air entraining admixture shall be ADDED DURING BATCHING ONLY.

(b) **Chemical Admixtures.** Chemical admixtures shall conform to AASHTO M 194 for the particular type specified.

(c) **High Range Water Reducer (HRWR) Concrete Mixture.** The use of a Type F and G HRWR in concrete mixes will require written approval of the Engineer and meet the additional requirements of this Subsection for each specific project. If a high range water reducing chemical admixture is to be used, the concrete mixture shall meet the requirements of Subsection 701.01 or 509.01 prior to the addition of the admixture.

When proposing the use of high range water reducer, provide a work plan with the mix design. Include the following in the work plan:

- *Purpose.* Describe the purpose for using a high range water reducing admixture.

- *Sequence.* Specify the batching sequence detailing when, where, and how HRWR is to be added to the mix.
- *Mixing Data.* Specify the mixer capacity and the mixing time and revolutions before and after the addition of the HRWR.
- *Redose.* Specify any condition that may require a redose include the redose dosage, permissible slump range for the redose, and the mixing time after redosing. Check air content after each redose.
- *Slump Loss.* Provide an estimate of slump immediately before and after the addition of the HRWR, slump during placement and finishing, and the total length of time the HRWR is effective. Base the estimate upon trial batches or data from previous work using a similar mix design and consider the time required for delivery, placement, finishing, and temperature.
- *Air Content.* For each slump estimate required above, provide a corresponding estimate of air content.

(d) **Corrosion-Inhibiting Admixtures.** When an approved corrosion-inhibiting admixture is required by the contract documents, the admixture shall meet the following requirements.

The admixture shall comply with the following characteristics when tested using the procedures described in AASHTO M194.

Physical Requirements for Corrosion-Inhibiting Admixture

Characteristic	Value
Calcium Nitrite Content	30%±2% (by weight)
Time of Setting, allowable deviation from control, (h:min)	
Initial, not more than:	1:00 earlier nor 3:30 later
Final, not more than:	1:00 earlier nor 3:30 later
Compressive Strength, minimum percent of the control, any time:	90
Flexural Strength, minimum percent of the control, any time:	90
Length Change, maximum shrinkage, percent of the control:	135
Relative Durability Factor, minimum:	80

The average corrosion current of the corrosion inhibitor-protected specimens shall be less than two microamps when tested according to ASTM G109 "Standard Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments." The test shall be run for three complete cycles after the control specimens have failed according to Section 8, Period of Testing.

Protection potentials (Ep) shall be more positive than -280 mV versus SCE when tested according to ASTM G61 "Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron, Nickel, or Cobalt-Based Alloys." The test medium shall be modified to contain a calcium hydroxide solution with a pH similar to concrete of 12.5, and sodium chloride content equivalent to approximately 5 lb/yd^3 ($3kg/m^3$) of concrete.

After five years of testing, the corrosion inhibitor-protected test specimens shall have a corrosion current in microamps of less than 10% of the control when tested according to ASTM G109. The test specimens shall have a minimum 1 inch (25mm) of concrete cover over the reinforcement and a maximum water-to-cement ratio of 0.40.

Unless otherwise specified, the concrete shall contain 4.0 gallons of corrosion inhibiting admixture per cubic yard (19.8 l/m^3). Account for possible set acceleration effects from the use of calcium nitrite based admixture. Set retarding admixtures may be required.

701.04. WATER.

All water used in mixing or curing Portland cement concrete or cement treated base shall be clean and practically free from oil, salt, acid, alkali, organic matter, or other substances injurious to the finished product.

Water from city water supply may be accepted without being tested.

Water from doubtful sources shall not be used until tested and approved. When required by the Engineer, the quality of the mixing water shall be determined in accordance with AASHTO T 26.

When tests are made comparing the water with water of known satisfactory quality, any indication of unsoundness, marked change in time of set, or reduction in mortar strength shall be sufficient cause for rejection of the water under test.

701.05. FINE AGGREGATE.

(a) **Materials Covered.** These Specifications cover the quality and size of fine aggregates for portland cement concrete pavements or bases, highway bridges, and incidental structures.
Mortar sand shall meet the requirements of AASHTO M 45.

(b) **General Requirements.** Fine aggregate shall consist of natural sand, or -subject to approval- combinations of manufactured sand and natural sand, having hard, strong, durable particles, and it shall conform to these Specifications.

Mix and store fine aggregate from different sources in separate stockpiles; in addition, do not use them alternately in the same class of construction or mix without permission from the Engineer or as provided herein for manufactured sand.

Stockpile fine aggregate in accordance with Subsection 106.09.

When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total fine aggregate by mass shall be natural sand. Store and batch the two materials separately. Each of the materials shall conform to the requirements of these Specifications, except that the mortar strength test shall be made on the blend of materials proposed for use.

(c) **Deleterious Substances.** The amount of deleterious substances shall not exceed the following limits:

ITEM	LIMITS
Clay lumps and friable particles, %, maximum	3.0
Coal and Lignite, %, maximum	0.25

(d) **Organic Impurities.** All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified below. Should the aggregate show a darker color than that of samples originally approved for the work, its use shall

be withheld until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

NOTE: A fine aggregate failing in the test may be used provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with Section 10 of AASHTO T 71 is not less than 95 percent.

(e) **Gradation.** Fine aggregate shall be well graded from coarse to fine, and when tested by means of laboratory sieves, it shall conform to the following requirements:

SIEVE SIZE	PERCENT PASSING
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	80-100
No. 16 (1.18 mm)	50-85
No. 30 (600 µm)	25-60
No. 50 (300 µm)	5-30
No. 100 (150 µm)	0-10
No. 200 (75 µm)	0-3

The gradation requirements given above represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, determine a fineness modulus (See Note). Determination shall be made from a representative sample obtained by the Engineer from the Contractor's proposed source. Reject fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample.

NOTE: The fineness modulus of an aggregate is determined by adding the total percentages of material in the sample that are coarser than each of the following sieves (cumulative percentages retained), and dividing the sum by 100; No. 100 (150 µm), No. 50 (300 µm), No. 30 (600 µm), No. 16 (1.18 mm), No. 8 (2.36 mm), No. 4 (4.75 mm), 3/8 inch (9.5 mm), 3/4 inch (19.0 mm), 1 1/2 inch (37.5 mm), and larger increasing at the ratio of 2 to 1.

(f) **Methods of Sampling and Testing.**

Sampling and testing of fine aggregate shall be in accordance with the following methods of the American Association of State Highway and Transportation Officials:

Sampling	T 2
Friable particles	T 112
Coal and lignite	T 113
Amount of passing a No. 200 (75 µm) sieve	T 11
Organic impurities	T 21
Mortar-making properties	T 71
Sieve analysis	T 27

701.06. COARSE AGGREGATE.

(a) **Materials Covered.** These Specifications cover the quality and size of coarse aggregate for use in portland cement concrete pavements or bases, highway bridges, and incidental structures.

(b) **General Requirements.** Stockpile coarse aggregate in accordance with Subsection 106.09.

Coarse aggregate shall be a gravel or crushed stone which shall conform to the requirements of AASHTO M 80, Class A, except as modified by these Specifications. Coarse aggregate shall produce Class A concrete with a durability factor of 50 or more. The durability factor will be determined after 350 cycles of alternate freezing and thawing in accordance with AASHTO T 161, Procedure A. The Los Angeles Abrasion percent wear shall be limited to a maximum of 40 percent after 500 revolutions when tested in accordance with AASHTO T 96. The sodium sulfate soundness requirement shall not apply.

Use only coarse aggregate shall consisting of clean, tough, durable particles, practically free from clay, shale, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter.

Crushed stone or crushed gravel from different sources may be combined in the mix when stored and batched separately in recommended proportions, upon written permission of the Engineer.

At least 70 percent of all aggregate retained on the No. 4 (4.75 mm) sieve in the combined mix shall be crushed stone or mechanically crushed gravel having two or more fractured faces and shall contain not more than 15 percent of flat and elongated pieces. (A flat and elongated piece is one in which the length is greater than five times the average thickness).

(c) **Gradation.** The coarse aggregate shall be well graded within the limits of the following table:

	Processed Aggregate Size Number				
	357	**57**	**67**	**7**	**8**
SIEVE SIZE	**PERCENT PASSING**				
2 1/2 inch (63 mm)	100				
2 inch (50 mm)	95-100				
1 1/2 inch (37.5 mm)		100			
1 inch (25.0 mm)	35-70	95-100	100		
3/4 inch (19.0 mm)			90-100	100	
1/2 inch (12.5 mm)	10-30	25-60		90-100	100
3/8 inch (9.5 mm)			20-55	40-70	85-100
No. 4 (4.75 mm)	0-5	0-10	0-10	0-15	10-30
No. 8 (2.36 mm)		0-5	0-5	0-5	0-10
No. 16 (1.18mm)					0-5
No. 200 (75mm)	0-1.5	0-2.0	0-2.0	0-2.0	0-2.0

1. Furnish coarse aggregate for Class A concrete in the No. 57 size only except as noted below.
2. Furnish coarse aggregate for massive Class A concrete in the No. 357 size. Coarse aggregate for Class C concrete may be either No. 57 or No. 357.
3. Furnish coarse aggregate for thin section concrete in the No. 7 size.

4. Coarse aggregate for Class AA or P concrete shall be furnished in the No. 67 size. No. 7 or No. 8 coarse aggregate may be used in Class P concrete if either the specified 28-day compressive strength is in excess of 6000 psi (41.4 MPa) or permeability limits are specified.

701.07. CURING AGENTS.

Concrete curing agents shall consist of burlap, cotton mats, earth, white or red pigmented membrane curing compound, waterproof paper, polyethylene film, linseed oil emulsion, or water for ponding. Keep the curing agents reasonably free from ingredients which may damage or be detrimental to the surface of the concrete.

(a) **Burlap.** Burlap cloth shall conform to AASHTO M 182, Class 3 or better.

Burlap shall be new burlap or burlap which has been used for no purpose other than the curing of concrete. New burlap, not previously used for curing concrete, shall be reasonably free from starch, filler, or other substances added during the process of manufacturing, or shall be washed by repeated rinsing in clear water until reasonably free from such substances. Worn burlap or burlap with holes will not be permitted. Burlap shall be at least 2 feet (600 mm) longer than the width of the pavement slab.

(b) **Cotton Mats.** Cotton mats shall be either new, or they shall not have been used for any other purpose than curing concrete. Do not use mats with holes.

(c) **Earth.** Earth used in curing concrete pavement shall be reasonably free of roots, sticks, stones, or other ingredients which may be detrimental to the surface of the concrete, and shall be of such nature as to retain moisture.

(d) **Liquid Membrane Curing Compounds.** Liquid membrane curing compounds shall conform to AASHTO M 148 with these exceptions:

The type 2, white pigmented compound hiding power shall have an apparent daylight reflectance of not less than 65 percent compared to magnesium oxide as determined by ASTM E 97.

The type 1-D compound shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least 4 hours, after which it should gradually disappear.

When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent.

(e) **Sheet Materials.** Sheet Materials shall conform to AASHTO M 171. Sheet material not specifically defined in AASHTO M 171 may be approved providing all other requirements of AASHTO M 171 are met.

The sheeting material shall be fabricated into sheets of such width as to provide a complete cover for the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint.

Do not use sections of membrane which have lost their moisture- retaining qualities.

(f) **Linseed Oil Emulsion.** Linseed oil emulsion shall comply with the following table of composition:

Composition	Mass Percent
Oil Phase (50% min. by volume)	
Boiled linseed oil	97.0 ± 0.1
Saturated Tallow Alcohols	3.0 ± 0.1
	100.0
Water Phase (50% Max. by volume)	
Water	99.60 ± 0.01
Sodium hydroxide	0.37 ± 0.01
Dipicolinic acid	0.03 ± 0.001
	100.00

The emulsion shall be stable at the time of application.

Fugitive Dye. Linseed oil emulsion shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least four (4) hours, after which it should gradually disappear within a couple of weeks.

Moisture Retention. When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent when applied at the rate of 1 gallon per 175 square feet (4.3 m^2/l).

Containers. All linseed oil emulsion furnished under this Specification shall be in plastic containers. Each container shall be marked or labeled with the manufacturer's name, contents "Linseed Oil Emulsion", lot number, and date of manufacture.

(g) **Water for Ponding and Material for Dikes.** Water for ponding shall be reasonably free from salt, acid, alkali, oil, or any substance that would injure or discolor the surface. Water suitable for use in mixing portland cement concrete will be satisfactory to use for ponding. Material for dikes shall be loam, sand, clay, or any combination of the above, free from rocks, sticks, or any objects that would prevent formation of a watertight dike.

701.08. JOINT FILLERS AND SEALERS.

This Subsection establishes the requirements for joint fillers and sealers for portland cement concrete.

(a) **Preformed Expansion Joint Filler (Bituminous Type).** This joint filler shall conform to the requirements of AASHTO M 33. Do not use this type filler in joints for which the Plan detail requires a sealer. Submit a type A certification from the manufacturer for each lot or shipment of materials.

(b) **Preformed Expansion Joint Fillers. (Nonextruding and Resilient Types)**.

1. *Nonbituminous Joint Filler.* The nonbituminous joint filler shall conform to AASHTO M 153.
2. *Bituminous Joint Filler.* The bituminous joint filler shall conform to the requirements of AASHTO M 213, except that the maximum permissible load to compress the test specimen to 50 percent of its thickness before testing shall be 1500 psi (10.34 MPa). Compliance with the asphalt content requirement is waived providing the material meets all other physical requirements as specified. Submit a type A certification from the manufacturer for each lot or shipment of materials.

(c) **Preformed Elastomeric Compression Joint Sealer.**

1. *Description.* These Specifications cover preformed elastomeric compression joint sealers for use in portland cement concrete pavements and concrete bridge floors.
2. *Materials.*

2.1. *Preformed Joint Seals.* The joint seals shall be manufactured from an elastomeric material that is resistant to heat, oil, jet fuel and ozone. The material shall be compatible with concrete and shall conform to the physical requirements of AASHTO M 220. All tests will be made on samples taken from the preformed joint sealer.

2.2. *Shape and Dimensions.* The molded joint seals shall be of cross sectional dimensions, lengths and tolerances shown on the Plans. The sealer shall be one piece for the full length of the transverse joint and in practical lengths for longitudinal joints.

Elongation of the joint material of more than 2 percent during placement will require the preformed elastomeric compression joint sealer to be removed and replaced.

2.3. *Samples.* Two 2 foot (600 mm) long pieces of each size of sealer to be used shall be submitted to the Materials Division for tests as warranted.

2.4. *Inspection.* Representative sections of each lot shall be subject to surface and dimensional inspection by the Engineer to determine visual compliance with applicable requirements of this Specification which do not require physical tests.

2.5. *Lubrication Adhesive.* Any lubricant adhesive used shall be compatible with the sealer and the concrete and relatively unaffected by the normal moisture in the concrete. The lubricant adhesive shall be a compound consisting of the same base polymer as the sealer, blended with a suitable volatile solvent. It shall maintain a suitable consistency at the temperature at which the seal is installed.

2.6. *Certification.* A type A certification shall be submitted by the manufacturer for each lot or shipment of materials.

Any cracking visible after recovery testing is basis for rejection.

(d) **Polymer Type, Two Component Cold Applied Machine Extruded and Pourable Joint Sealer.**

1. *Description.* These Specifications cover two- component, polymer- type, rubberlike, cold- applied joint sealing compounds for use in portland cement concrete pavements and bridge floors.

When recommended by the manufacturer, use a primer in accordance with the manufacturer's recommendation.

The shape of the joint and joint sealer shall be as shown on the Plans.

2. *Materials.* Materials meeting Federal Specifications SS-S-200 may be used. Use the bond breaker recommended by the materials manufacturer as shown on the ODOT standard drawings.

2.1. *Acceptance.* Furnish a type A certification with each shipment or lot.

2.2. *Packaging.* Package the joint sealer in sealed containers identified by the name of the manufacturer, the manufacturer's lot number, and the date of manufacture, and bearing instructions for mixing and application. Containers including the curing agent shall be marked A, and the container including the polymer shall be marked B. If a primer is required by the manufacturer, it must be so stated on containers A and B. Give proper instructions for use of the primer on its container.

2.3. *Tests.* Tests shall be made in accordance with OHD L-21.

3. *Machine Extruded Joint Sealer.*

3.1. *General.* The joint sealer shall be a modified polysulfide or polyurethane polymer consisting of 2 components to be machine mixed and machine extruded directly into the joints.

The polysulfide components shall be mixed at a 1:1 ratio by volume and the polyurethane components shall be mixed in accordance with the manufacturer's recommendations.

Upon being opened, component B shall not exhibit more than a slight degree of skinning.

3.2. *Properties of Laboratory Mixed Material.*

Determination	**Requirements**
Penetration, 77°F, 0.1 mm (25°C)	50 to 120
Penetration, 158°F (70°C)	1.5 x Pen. at 25°C
Cold Flow, 3 minutes, mm, minimum	19.1
Cold Flow, 40 minutes, mm, maximum	12.7
Resilience, 77°F (25°C), %, minimum	70
	60[a]
Resilience of oven aged sample, 7 days, %, minimum	70
	60[a]
Resilience, 158°F (70°C), %, minimum	60
	50[a]
Bond to concrete[b], 100% extension, dry, -20°F (-29°C)	No failure
Bond to concrete[b], 100% extension, wet, -20°F (-29°C)	No failure
Nonvolatile content, %, minimum	88

[a]Applies if penetration at 77°F is 90 to 120(0.1mm) (25°C is 90 to 120)

[b] Cure Sample for 24 hours at 77°F (25°C); then oven age for 7 days at 158°F±2°F (70 ± 1°C).

4. *Pourable Joint Sealer.*

4.1. *General.* The joint sealer shall be a polymeric material consisting of two components to be uniformly mixed and poured directly into the joints. The mass of component A in the mixture shall be not less than 10 percent of the mass used of component B.

Upon being opened, neither component shall exhibit more than a slight degree of skinning.

4.2. *Properties of Laboratory Mixed Material*

Determination	Requirements
Viscosity, 5 minutes after mixing, Pa·s	2.00 to 3.50
Application time (Pot life or time to reach 20.00 Pa·s), 77°F (25°C), hr, minimum	1
Penetration, 77°F (25°C), 24 hours aging, maximum	150
Penetration[a], 77°F (25°C)	50 to 120
Penetration[a], 158°F (70°C)	1.5 x Pen @ 25°C
Resilience[a], 77°F (25°C), %, minimum	70
	60[b]
Resilience[a], 158°F (70°C), %, minimum	60
	50[b]
Resilience[a], oven aged sample, 7 days, %, minimum	70
	60[b]
Bond to Concrete[c], 100% extension, dry, -20°F (-29°C)	No failure
Bond to Concrete[c], 100% extension, wet, -20°F (-29°C)	No failure
Nonvolatile content, %, minimum	88

[a] After 96 hours aging at 77°F (25°C)

[b] This requirement applies if penetration at 77°F (25°C) after 96 hours at 77°F is 90 to 120(0.1mm) (25°C is 90 to 120).

[c] Cure sample for 24 hours at 77°F (25°C), then oven age at 158°F±2°F (70°C ± 1°C) for 7 days before testing.

(e) **Hot Poured Joint Sealer.**

1. *Description.* Joint sealers furnished shall be of the hot poured type which readily bonds to concrete surfaces.
2. *Materials.*

2.1. *Sealer.* Joint sealers used under these Specifications shall meet the requirements of Federal Specification SS-S-1401. The sealant material shall be heated for application to the temperature within the range recommended by the manufacturer unless otherwise established by the Engineer.

2.1.1. *Safe Heating Temperature.* The safe heating temperature shall be set forth by the manufacturer and furnished with samples for approval. The safe heating temperature shall also be shown on all containers and packages in each shipment received at the job site.

2.1.2. *Acceptance.* Hot poured joint sealer furnished under these Specifications will be accepted for use upon receipt of a type C certification in accordance with Subsection 106.04.

Sealer materials damaged by excessive or prolonged heating will be rejected.

2.2. *Backer Rod.* When shown on the Plans, the use of a backer rod of the size and dimensions shown shall be required. The backer rod shall be compatible with the joint sealant. The backer rod shall be an approved product listed for use by the Materials Division.

(f) **Low Modulus Silicone Joint Sealant.**

1. *Description.* These Specifications cover low modulus silicone joint sealant and expanded polyethylene backer rod for use in sealing portland cement concrete pavement joints. The silicone sealant shall be furnished in a one part silicone formulation. Acetic acid cure sealants are not acceptable.
2. *Materials.*

2.1. *Silicone Sealant.* The silicone sealant shall meet the color, toxicity, stability, and durability requirements of the current Federal Specification TT-S-001543 for Class A sealants and the following test requirements:

Test	Limit	Test Method
Flow, inches (mm), maximum	0.3 (7.6)	MIL S 8802
Extrusion Rate, g/minute	75-250	MIL S 8802
Tack Free Time, 77°F (25°C), 45-55% relative humidity, minutes	20-75	MIL S 8802
Specific Gravity	1.01 - 1.515	ASTM D 792 Method A[a]
Durometer, Shore A, 0°F (-17.8°C)	10-27	ASTM D 2240[a]
Tensile Stress, 100% Elongation, psi (kPa), maximum	75 (517)	ASTM D 412 Die C[a]
Elongation, %, minimum	500	ASTM D 412 Die C[a]

[a] Cured 7 days at 77°F±4°F (25 ± 2°C) and 50 ± 5 percent relative humidity.

Concrete primer may be used if specified by the sealant manufacturer.

2.1.1. *Acceptance.* The sealant shall be accepted on the basis of manufacturer's certification and approval by the Materials Engineer in accordance with Subsection 106.04.

A type A certification shall be furnished for the above listed test requirements.

A type D certification shall be required for compliance with current Federal Specification TT-S-001543 in accordance with Subsection 2.1 of these Specifications.

Samples of the joint sealant shall be submitted by the manufacturer to the Materials Division for tests and approval prior to use.

2.1.2. *Storage and Shelf Life.* Storage and use of the joint sealant shall be in accordance with the manufacturer's recommended practices.

2.2. *Backer Rod.* The backer rod shall be of the size and dimensions shown on the Plans. The backer rod shall be compatible with the joint sealant and no bond or reaction shall

occur between the rod and sealant. The backer rod shall be an approved product listed for use by the Materials Division.

(g) **Low Modulus Silicone Joint Sealant (Self-Leveling).**

1. *Description.* These Specifications cover self-leveling, low modulus silicone joint sealants and polyethylene backer rod for use in sealing portland cement concrete pavement joints and/or portland cement concrete to asphalt concrete pavement joints. The self-leveling silicone sealant shall be furnished in a one part silicone formulation. Acetic acid cure sealants are not acceptable.
2. *Materials.*

2.1 *Silicone Sealant.* The silicone sealant shall meet the color, toxicity, stability, and durability requirements of the current Federal Specification TT-S-001543 for Class A sealants and the following test requirements:

Test	Limit	Test Method
Appearance	Smooth, non-grainy, homogeneous mixture	MIL S 8802
Extrusion Rate, g/minute, minimum	200	MIL S 8802
Tack Free Time, 77°F (25°C), 45-55% relative humidity, hr	5	MIL S 8802
Specific Gravity	1.26-1.34	ASTM D 792, Method A
Elongation, %, minimum	500	ASTM D 3583-85 Section 13, Modified[a]
Modulus @ 50%, psi (kPa), maximum	10(69)	ASTM D 3583-85 Section 13, Modified[a]
Modulus @ 100%, psi (kPa), maximum	15(103)	ASTM D 3583-85 Section 14, Modified[a]
Modulus @ 150%, psi (kPa), maximum	20(138)	ASTM D 3583-85 Section 14, Modified[a]

[a] Clean two 1x1x3 inch (25.4 x 25.4 x 76.2 mm) concrete test blocks, hold under running tap water, and scrub with a brush for approximately 30 seconds. Allow blocks to dry for 24 hours at room temperature. Assemble blocks with 1x3 inch surface facing (with 25.4 x 76.2 mm surfaces facing) with 1/2 x 1/2 x 1 inch (12.7 x 12.7 x25.4mm) Teflon spacers. Hold in place with a clamp. Without touching the surface with your fingers, insert backer rod closed cell 1/2 inch diameter x 1 inch (closed cell 12.7 mm diameter x 25.4 mm). Inject sealant to fill the cavity with no air entrapment. Allow the sealant to flow to a smooth surface, and do not strike off. Allow it to cure at 77°F (25°C) and 45-55% relative humidity. After 21 days, remove the clamp and Teflon spacers and pull the test specimens at 2 inches (50.8 mm) per minute.

2.1.1. *Acceptance.* The sealant shall be accepted on the basis of the manufacturer's certification and approval by the Materials Engineer in accordance with Subsection 106.04.

Furnish a type A certification for the above listed test requirements.

Furnish a type D certification to comply with current Federal Specification TT-S-001543 in accordance with Subsection 2 of these Specifications.

Submit samples of the joint sealant to the Materials Division for tests and approval prior to use.

2.1.2. *Storage and Shelf Life.* Storage and use of the joint sealant shall be in accordance with the manufacturer's recommended practices.

2.2. *Backer Rod.* The backer rod shall be of the size and dimensions shown on the Plans. The backer rod shall be compatible with the joint sealant, and no bond or reaction shall occur between the rod and the sealant. The backer rod shall be an approved product listed for use by the Materials Division.

(h) **Rapid Cure Joint Sealant and Elastomeric Mortar.**

1. *Description.* These Specifications cover rapid cure joint sealant and elastomeric mortar for use in expansion joints in bridge decks.
2. *Materials.*

2.1. *Joint Sealant.* Joint sealer shall be a self-leveling, rapid cure silicone joint sealant that cures to a low-modulus rubber upon exposure to atmospheric moisture. Rapid cure is defined as the development of sufficient integrity within the silicone in 8 hours or less to accommodate highway traffic and movements associated with bridges. Deliver each lot or batch of sealing compound to the job site in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, and batch or lot number, and shall be accompanied by the manufacturer's certification. Petroleum products shall not be deleterious to the sealant. Joint sealant shall meet the following requirements:

Test	**Limit**	**Test Method**
AS SUPPLIED:		
Extrusion Rate, g/minute, minimum	200	MIL S 8802
Specific Gravity	1.25 - 1.35	ASTM D 1475

AS INSTALLED - AT 77°F (25°C) AND 46-54% RH:		
Accelerated Weathering, 5,000 hours	No cracks, blisters or bond loss	ASTM C 793-75
Skin-over time, minutes, maximum	20	OHD L-3
Non-volatile content, %, minimum	93	OHD L-4
Joint Elongation, %, minimum	600	ASTM D 3583-85
Joint Modulus at 100%, psi (kPa)	3-12 (20.7 - 82.7)	ASTM D 3583-85[a]

[a] Section 14, Modified: Clean six 1x1x3 inch (25.4 x 25.4 x 76.2 mm) concrete blocks; hold under running tap water and scrub with a brush for approximately 30 seconds. Allow blocks to dry for 24 hours at room temperature. Assemble blocks with 1x3 inch (25.4 x 76.2 mm) surfaces facing with

1/2 x1/2 x 1 inch (12.7 x 12.7 x 25.4 mm) Teflon spacers; hold in place with a clamp. Insert backer rod, closed cell, 1/2 inch diameter by 2 inches (12.7 mm diameter by 50.8 mm); do not touch surface with fingers. Inject sealant to fill the cavity, with no air entrapment. Allow the sealant to flow to a smooth surface, do not strike off. Allow to cure at 77°F (25°C) and 46-54% relative humidity. Cure for 160 hours, remove clamp and Teflon spacers, and pull the test specimens at 2 inches (50.8 mm) per minute.

2.2. *Elastomeric Mortar.* The binder material shall be a two-component, rapid curing liquid polymer that cures to a dense, semi-flexible polymer resistant to chemicals, weather, abrasion and impact. The binder material shall be compatible with the sealant, as determined by the sealant manufacturer. The binder shall be cured in the "neat" to form the primer between the elastomeric mortar and the existing surfaces and shall be mixed with aggregate to form the polymer based mortar. Aggregate for the elastomeric mortar shall be compatible with the liquid polymer (binder material), as determined by the manufacturer. Properties for the binder material shall conform to the following requirements:

COMBINED LIQUID COMPONENTS
(The mixing ratio shall be 1:1 by volume)

Test	**Limit**	**Test Method**
Viscosity, Pa·s, 75°F±2°F (23.9°C ± 1.1°C) (Brookfield Model LVT) (Spindle No. 2, 30 RPM)	0.9 - 2.0	ASTM D 2393
Gel Time, minutes	25 - 60	AASHTO M-200
Elongation, %	40 - 55	ASTM D 638[a]
Tensile Strength, psi (MPa), minimum	900 (6.21)	ASTM D 638[a]
Shore D Hardness, 77°F (25°C), 7 day cure	45 - 75	ASTM D 2240

[a] Test Method Type 1, Molded Specimens, 1/4 inch (6.4 mm) thickness; speed of testing shall be 0.2±0.05 inch (5.1 ± 1.3 mm).

Properties for the elastic mortar shall conform to the following:

Test	Limit	Test Method
Absorption, %, maximum	1.0	ASTM D 570
Compressive Strength, 24 hr, psi (MPa), Method B, minimum	2500 (17.24)	ASTM C 579
Bond Shear Strength, psi (MPa), minimum	750 (5.17)	ASTM C 882
Abrasion Resistance Wear Index, Taber H-22, maximum	1.5	ASTM C 501
Compressive Stress, psi (MPa), minimum	350 (2.41)	OHD L-6
Resilience, %, minimum	70	OHD L-6
Thermal Compatibility	Pass	ASTM C 884

2.3. *General Use Procedure.* Mixing and application time shall be as recommended by the manufacturer. No modification of the elastomeric mortar should be attempted without first consulting the manufacturer.

2.4. *Acceptance and Sampling.* The sealant and elastomeric mortar shall be accepted on the basis of the manufacturer's certification in accordance with Subsection 106.04 and acceptable performance on the project. A type A certification shall be furnished for the joint sealant, except a type B certification shall be furnished for the Accelerated Weathering test. A type B certification will be furnished for elastomeric mortar, except a type A certification will be furnished for the binder material. Samples of the rapid cure joint sealant, and the binder material and aggregate for the elastomeric mortar, shall be submitted by the manufacturers to the Materials Division for testing and evaluation.

2.5. *Backer Rod.* Backer rod shall be in accordance with Subsection 419.04(d) of the Standard Specifications.

2.6. *Primer.* Primer shall be applied as detailed in the plans prior to installation of the sealant or as specified by the sealant manufacturer.

2.7. *Alternate Joint Products.* When alternate expansion joint systems are specified on the plans, the Contractor may use the alternate joint system in place of the nosing and sealant specified above. Sealants and nosing material may be considered as an equal alternate to the above specified materials provided that they successfully complete a 3-year trial installation and evaluation in the State of Oklahoma as determined by the Bridge Engineer.

701.09. METAL PARTING STRIPS.

These Specifications cover metal parting strips for use in forming longitudinal joints in concrete pavement or concrete base course.

Metal parting strips shall be shaped from metal of the sheet thickness shown on the Plans and shall be free from bends and kinks. They shall conform to the dimensions and be punched for pins and tie bars as shown on the Plans. Punching for pins may not be farther apart than 3 feet (915 mm) center to center. Sections of metal parting strips shall be not less than 10 feet (3.0 m) in length and so designed

that adjoining sections may be securely fastened together by lapping and pinning, by means of a slip joint or other approved method.

701.10. HIGH DENSITY CONCRETE FOR BRIDGE DECK REPAIR AND OVERLAY.

This Subsection covers the material requirements for high density concrete used for bridge deck repairs and/or overlays.

(a) **Aggregate.**

1. *Fine Aggregate.* The fine aggregate shall meet all requirements of Subsection 701.05 except for gradation.
2. *Coarse Aggregate.* The coarse aggregate shall be a crushed stone containing no chert or shale and having a minimum durability of 50 as determined by AASHTO T 210. The coarse aggregate shall meet all other requirements of Subsection 701.06 and shall have an absorption of not more than 3 percent by mass.
3. *Gradation.* The combined aggregate shall meet the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	75 - 90
3/8 inch (9.5 mm)	62 - 80
No. 4 (4.75 mm)	38 - 54
No. 16 (1.18 mm)	16 - 32
No. 30 (600 µm)	10 - 20
No. 50 (300 µm)	4 - 12
No. 100 (150 µm)	2 - 8
No. 200 (75 µm)	0 - 4

(b) **Concrete.** The concrete shall meet the following requirements:

Basic Absolute Volumes per Unit Volume of Concrete.

Combined Aggregate	0.6194
Air Content	0.0650
Water	0.1601
Cement	0.1555
	1.0000

A water-reducing admixture meeting the requirements of Subsection 701.03 shall be used. The slump, measured in accordance with AASHTO T 119, shall be 3/4 inch ± 1/4 inch (20 ± 5 mm). The air content of the freshly mixed concrete shall be 6.5 ± 1.0 percent when tested in accordance with AASHTO T 152 or T 196.

(c) **Grout.** Grout for bonding new concrete to existing concrete shall consist of equal parts by mass of portland cement and sand, mixed with sufficient water to form a stiff slurry. The consistency of this slurry shall be such that it can be applied with a stiff brush or broom to the old concrete in a thin, even coating that will not run or puddle in low spots. For sealing vertical joints around repair or between adjacent lanes of overlay and at curbs, this grout shall be thinned to paint consistency.

701.11. LATEX MODIFIED CONCRETE FOR BRIDGE DECK OVERLAYS.

Description. This Subsection covers the material requirements for latex modified concrete for bridge deck overlays.

(a) **Aggregate.**

1. *Fine Aggregate.* The fine aggregate shall meet all requirements of Subsection 701.05 except for gradation.
2. *Coarse Aggregate.* The coarse aggregate shall be a crushed stone containing no chert or shale and having a minimum durability factor of 50 as determined by AASHTO T 210 and have an absorption of not more than 3 percent. The coarse aggregate shall meet all other requirements of Subsection 701.06.
3. *Gradation.* The combined aggregate shall meet the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	68 - 83
3/8 inch (9.5 mm)	56 - 70
No. 4 (4.75 mm)	36 - 46
No. 16 (1.18 mm)	12 - 24
No. 30 (600 µm)	7 - 17
No. 50 (300 µm)	4 - 12
No. 100 (150 µm)	2 - 8
No. 200 (75 µm)	0 - 4

(b) **Latex Emulsion Admixture.** Formulated latex admixture shall be nontoxic, film forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and shall be homogenous and uniform in composition. Physical properties of the latex modifier shall conform to the following requirements:

Polymer Type **Stabilizers**	**Styrene Butadiene**
(1) Latex	Nonionic Surfactant
(2) Portland Cement Composition	Poly-dimethyl Siloxane
Percent Solids	46.0 - 49.0
Mass per Unit Volume, lbs/gallon, 77°F (kg/l, 25°C)	8.4 (1.007)
Color	White

A type D certification of materials will be required and shall be furnished to the Materials Engineer before acceptance of the product.

Latex admixture to be stored shall be kept in suitable enclosures which will protect it from freezing and from prolonged exposure to temperatures in excess of 29°C. Containers of latex admix-

ture may be stored at the bridge site for a period not to exceed 10 days. Such stored containers shall be covered completely with suitable insulating blanket material to avoid excessive temperatures.

(c) **Latex Modified Concrete.** The latex modified concrete for use in overlay shall be a workable mixture having the following properties or limits:

Material or Property	Concrete
Cement (Parts by Mass)	1
Fine Aggregate (Parts by Mass)	2.5
Coarse Aggregate (Parts by Mass)	2.0
Latex Emulsion Admixture, gallon/bag (mL/Kg) cement	3.5 (311)
Air Content, %	3-6
Slump[a,b], inches (mm)	4-6 (100-150)

[a] Following sampling of the discharged, normally mixed material, the commencement of the slump test shall be delayed from 4 to 4-1/2 minutes.

[b] Water may be added to obtain slump within the prescribed limits, but the water-cement ratio produced should be between 0.35-0.40 by mass. All of the nonsolids in the latex admixture should be considered as a part of the water.

701.12. PENETRATING WATER REPELLENT FOR TREATMENT OF CONCRETE SURFACES.

Description. This Subsection covers the material requirements for penetrating water repellents for use on concrete surfaces.

(a) **General.** The penetrating water repellent treatment solution shall be an organo silicon compound dissolved in a suitable solvent carrier that, when applied, will produce a hydrophobic surface covalently bonded to the concrete. The organo silicon compound shall be one of the following:

ALKYL-ALKOXYSILANE
OLIGOMEROUS ALKYL-ALKOXYSILOXANE

The solvent shall leave less than one percent residue by mass upon evaporation.

The penetrating water-repellant treatment solution shall not permanently stain, discolor, or darken the concrete. Application of the solution shall not alter the surface texture or form a coating on concrete surfaces and shall be compatible with the use of special surface finish texture coatings specified in Subsection 509.04(g). Treated concrete shall be surface dry within 30 minutes after application.

The penetrating water repellent treatment solution shall be tinted with a fugitive dye to enable the solution to be visible on the treated concrete surface for at least four hours after the application. The fugitive dye shall not be conspicuous more than seven days after application when exposed to direct sunlight.

(b) **Certification.** A type D certification shall be submitted for each lot or shipment of materials prior to use. The manufacturer's recommended rate of coverage for the treatment solution as approved for use under these Specifications shall be included with the type D certification.

701.13. EPOXY RESIN ADHESIVES FOR GENERAL USE WITH CONCRETE.

Description. This Subsection covers two component, epoxy-resin bonding systems for application to portland cement concrete.

(a) **General.** Epoxy-resin adhesives for general use with concrete shall comply with AASHTO M 235. If the type, grade and class of epoxy-resin is not specified on the Plans or in the Proposal, the Contractor shall furnish an epoxy-resin system that is appropriate for its intended use in accordance with AASHTO M 235.

Epoxy-resin adhesives for bonding pavement markers to pavement surfaces shall meet the requirements of Subsection 736.04 of these Specifications.

(b) **Acceptance.** The Contractor shall furnish a type A certification for each batch or lot of each component.

701.14. WHITE CONCRETE.

Description. This Subsection covers the requirements for furnishing white Portland Cement concrete for median barriers specified under Section 627.

(a) **Materials.** When white Portland Cement concrete is specified on the Plans, the following requirements shall supplement the general provision for Portland Cement concrete.

1. *Cement.* Cement shall be white Portland Cement and meet the requirements of ASTM C150 and AASHTO M-85 for Type 1 Portland Cement, except that the cement shall contain not more than 0.50% by mass of ferric oxide ($Fe_2 0_3$).
2. *Fine Aggregate.* Fine aggregate shall be light in color. The fine aggregate to be used in white concrete shall meet the requirements of Subsection 701.05 of the Standard Specifications.
3. *Coarse Aggregate.* Coarse aggregate shall be light colored. The coarse aggregate shall be either No. 57 or 67, be free of discoloring and shall meet the requirements of Subsection 701.06 of the Standard Specifications.
4. *Water.* Potable water, free from iron or other impurities which may cause staining, shall be used as mixing water.
5. *Proportioning.* White concrete mixes shall be proportioned using ACI 211.1, "Standard Practice for Selecting Proportions for Normal Heavyweight and Mass Concrete." A white concrete mix for use in barrier construction will contain 660 lb/cy (392 Kg/m^3) of white Type 1 cement, air content of 6 ± 1% and a slump of 3± 1 inch (75 ± 25 mm). Maximum water cement ratio shall be 0.53 , and minimum compression strength shall be 3000 psi (20.68 MPa) in 28 days.

(b) **Batching and Mixing.** Equipment for batching and mixing of white concrete shall be clean to prevent contamination by material which may contribute to discoloration. Cement bins and weigh hoppers shall be free of loose gray Portland Cement and truck mixers shall be cleaned to remove all loose gray concrete from the mixer drum.

(c) **Surface Finish.** When white concrete median barriers are constructed in metal forms, take care to select a form oil which will not stain the surface of the white concrete. The surface shall be treated with penetrating water repellent solution in accordance with Section 515 at the rate recommended by the manufacturer.

(d) **Acceptance.** The white concrete barrier or parapet shall be as white or whiter than a 10Y91 when compared to the Munsell Book of Color. Before production of the white concrete barrier or parapet, the Contractor will prepare and submit to the Engineer for approval a 1 square foot (300x300 mm) test panel using the materials proposed for use in the construction. The approved test panel shall be used as a standard for the remainder of the work.

701.15. AGGREGATES FOR ECONOCRETE BASE.

(a) **Materials Covered.** These Specifications cover the requirements for aggregate used in econocrete bases.

(b) **General Requirements.**

1. **Alternate One**. Fine aggregate shall comprise 40 to 60 percent of the aggregate and shall meet the requirements of Subsection 701.05. Coarse aggregate shall be size no. 57 and shall meet the requirements of Subsection 701.06.
2. **Alternate Two**. Fine aggregate shall meet the requirements of Subsection 701.05, except the gradation requirements do not apply. Coarse aggregate shall meet the requirement of Subsection 701.06, except the gradation requirements do not apply. The combined aggregate for econocrete base shall have a minimum sand equivalent of 45 when tested in accordance with AASHTO T176 and shall conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
1 1/2 inch (37.5 mm)	100
1 inch (25.0 mm)	70-100
1/2 inch (12.5mm)	55-85
No. 4 (4.75mm)	30-60
No. 40 (425µm)	10-30
No. 200 (75µm)	1-15

Recycled portland cement concrete pavement may be used under this subsection. When recycled portland cement concrete pavement is used as the sole source of coarse aggregate, the durability factor determined by AASHTO T161, Procedure A shall be waived and the Los Angeles Abrasion percent wear determined by AASHTO T96 shall be limited to a maximum of 50 percent wear after 500 revolutions.

3. **Notification.** The Contractor shall notify the Engineer in writing at the time of his design mix submittal as to which alternate he will use.

(c) **Sampling and Testing.** Sampling and testing shall be in accordance with the applicable methods of Subsections 701.05 and 701.06.

701.16. AGGREGATE FOR OPEN GRADED PORTLAND CEMENT CONCRETE BASE.

(a) **Materials Covered.** These Specifications cover the requirements for aggregate used in open graded portland cement concrete bases.

(b) **General Requirements.** Aggregate shall be stockpiled in accordance with Subsection 106.09.

Aggregate shall be a gravel or crushed stone which shall conform to the requirements of AASHTO M 80, Class A, except as modified by these Specifications.

Aggregate shall consist of clean, tough, durable particles, practically free from clay, shale, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter, and shall meet the requirements as follows:

PHYSICAL PROPERTIES OF AGGREGATES	
L. A. Abrasion (max. % wear)	40
Mechanically Fractured Faces (min. %)[a]	70 w/2
Aggregate Durability Index, (min.)	40
Flat or Elongated Pieces[a,b] (max. %)	15
Clay Balls and Friable Particles (max. %)	0
Soft Particles (max. %)	5
Sticks or Roots (max. %)	0

[a] Applies to the aggregate retained on the No. 4 (4.75 mm) sieve.

[b] A flat or elongated piece is one in which the length is greater than five times the average thickness.

(c) **Gradation.** The aggregate shall conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING
1 1/2 inch (37.5 mm)	100
1 inch (25.0 mm)	95 - 100
1/2 inch (12.5 mm)	25 - 60
No. 4 (4.75 mm)	0 - 10
No. 8 (2.36 mm)	0 - 5
No. 200 (75 µm)	0 - 2

(d) **Sampling and Testing.** Sampling and testing shall be in accordance with the applicable methods of Subsection 701.06.